

CLAIMS

1 1. A gas discharge panel production method comprising:

2 a surrounding unit forming step for forming a
3 surrounding unit by putting a first panel and a second panel
4 together, wherein barrier ribs for partitioning light-emitting
5 cells are formed on a main surface of the first panel, and the
6 first panel and the second panel are put together to face each
7 other with the barrier ribs in between; and

8 a sealing step for sealing the surrounding unit with
9 a sealing material inserted between the first panel and the
10 second panel at the rim, wherein

11 the sealing step includes:

12 a pressure adjustment sub-step for adjusting pressure
13 so that pressure inside the surrounding unit is lower than
14 pressure outside the surrounding unit.

1 2. The gas discharge panel production method of Claim 1,
2 wherein

3 the pressure adjustment sub-step starts before the
4 sealing material hardens.

1 3. The gas discharge panel production method of Claim 2,
2 wherein

3 the sealing material softens when an energy is given

4 from outside, and

5 in the sealing step, the sealing material is first
6 softened then hardened to seal the surrounding unit.

1 4. The gas discharge panel production method of Claim 2 or
2 Claim 3, wherein

3 in the surrounding unit forming step, a connection
4 path which connects inside of the surrounding unit to outside of
5 the surrounding unit is formed in the surrounding unit, and

6 in the pressure adjustment sub-step, gas is exhausted
7 from inside of the surrounding unit to outside of the
8 surrounding unit via the connection path.

1 5. The gas discharge panel production method of Claim 4,
2 wherein

3 the surrounding unit is provided with an air vent
4 which connects inside of the surrounding unit to outside of the
5 surrounding unit, and a pipe is connected to the air vent with
6 a crystallized glass in between, and

7 in the pressure adjustment sub-step, gas is exhausted
8 from inside of the surrounding unit to outside of the
9 surrounding unit via the pipe.

1 6. The gas discharge panel production method of Claim 1,
2 wherein

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3 the sealing step includes:

4 an airtightly seal sub-step for interrupting gas flow
5 between inside and outside of the surrounding unit, and

6 in the pressure adjustment sub-step, pressure inside
7 the surrounding unit after the airtightly seal sub-step is
8 adjusted to be lower than before the airtightly seal sub-step.

1 7. The gas discharge panel production method of Claim 6,
2 wherein

3 in the pressure adjustment sub-step, a container whose
4 inside is under a pressure lower than the pressure inside the
5 surrounding unit is used to reduce the pressure inside the
6 surrounding unit.

1 8. The gas discharge panel production method of Claim 7,
2 wherein

3 in the surrounding unit forming step, the container
4 is attached to the surrounding unit, wherein a shielding
5 material interrupts gas flow between the container and the
6 surrounding unit, and

7 in the pressure adjustment sub-step, the interruption
8 by the shielding material is released to reduce the pressure
9 inside the surrounding unit.

1 9. The gas discharge panel production method of Claim 8,

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2 wherein

3 the shielding material either melts or dissolves when
4 a stimulus is given, and

5 in the pressure adjustment sub-step, the stimulus is
6 given to the shielding material so that the shielding material
7 melts or dissolves to release the interruption by the shielding
8 material and enable the gas to flow between the container and
9 the surrounding unit.

1 10. The gas discharge panel production method of Claim 6,
2 wherein

3 in the surrounding unit forming step, a container is
4 attached to the surrounding unit, wherein inside of the
5 container is connected to inside of the surrounding unit, and

6 in the pressure adjustment sub-step, to reduce the
7 pressure inside the surrounding unit, temperature in the
8 container is reduced to a degree lower than a degree before the
9 airtightly seal sub-step.

1 11. The gas discharge panel production method of Claim 6,
2 wherein

3 in the pressure adjustment sub-step, to reduce the
4 pressure inside the surrounding unit, temperature in the
5 surrounding unit is reduced to a degree lower than a degree
6 before the airtightly seal sub-step.

1 12. The gas discharge panel production method of Claim 6,
2 wherein

3 in the airtightly seal sub-step, the surrounding unit
4 is heated to soften the sealing material and seal the rim of the
5 surrounding unit so that gas flow between inside and outside of
6 the surrounding unit is interrupted.

1 13. The gas discharge panel production method of Claim 12,
2 wherein

3 in the surrounding unit forming step, a connection
4 path which connects inside of the surrounding unit to outside of
5 the surrounding unit is formed in the surrounding unit, and

6 in the airtightly seal sub-step, the surrounding unit
7 is heated to soften the sealing material and seal the rim of the
8 surrounding unit and the connection path is sealed so that gas
9 flow between inside and outside of the surrounding unit is
10 interrupted.

1 14. The gas discharge panel production method of Claim 6,
2 wherein

3 a gas adsorption member is disposed in the surrounding
4 unit in the surrounding unit forming step, or the gas adsorption
5 member is disposed in a container whose inside is connected to
6 inside of the surrounding unit, and

7 in the pressure adjustment sub-step, the pressure
8 inside the surrounding unit is reduced by a gas adsorption
9 action of the gas adsorption member.

1 15. The gas discharge panel production method of Claim 14,
2 wherein

3 the gas adsorption member holds gas by adsorption in
4 reaction to a stimulus given from outside, and

5 in the pressure adjustment sub-step, the stimulus is
6 given to the gas adsorption member so that the gas adsorption
7 member holds gas by adsorption.

1 16. The gas discharge panel production method of Claim 15,
2 wherein

3 in the pressure adjustment sub-step, the stimulus is
4 given to the gas adsorption member so that the gas adsorption
5 member holds gas by adsorption after the airtightly seal sub-
6 step starts.

1 17. The gas discharge panel production method of Claim 6,
2 wherein

3 in the surrounding unit forming step, a container is
4 attached to the surrounding unit, wherein inside of the
5 container is connected to inside of the surrounding unit, and
6 the surrounding unit is filled with a gas whose molecules bond

7 to each other, wherein the container may also be filled with the
8 gas whose molecules bond to each other, and

9 in the pressure adjustment sub-step, the pressure
10 inside the surrounding unit is reduced as the molecules of the
11 gas bond to each other.

1 18. The gas discharge panel production method of Claim 17,
2 wherein

3 the molecules of the gas bond to each other when a
4 stimulus is given from outside, and

5 in the pressure adjustment sub-step, the stimulus is
6 given to the gas so that the molecules of the gas bond to each
7 other.

1 19. The gas discharge panel production method of Claim 18,
2 wherein

3 in the pressure adjustment sub-step, the stimulus is
4 given to the gas after the airtightly seal sub-step starts.

1 20. The gas discharge panel production method of Claim 1,
2 wherein

3 the sealing step includes:

4 an airtightly seal sub-step for interrupting gas flow
5 between inside and outside of the surrounding unit, and

6 in the pressure adjustment sub-step, pressure outside

7 the surrounding unit after the airtightly seal sub-step is
8 adjusted to be higher than before the airtightly seal sub-
9 step.

1 21. The gas discharge panel production method of one of Claims
2 6 to 20, wherein
3 the sealing material softens when a stimulus is given
4 from outside, and
5 in the airtightly seal sub-step, the stimulus is given
6 to the sealing material to soften the sealing material so that
7 gas flow between inside and outside of the surrounding unit is
8 interrupted, and
9 the pressure adjustment sub-step is performed after
10 the airtightly seal sub-step starts.

1 22. The gas discharge panel production method of one of Claims
2 6 to 20, wherein
3 the sealing step includes:
4 a preparatory sealing sub-step for sealing the
5 surrounding unit with another sealing material different from
6 the sealing material before the surrounding unit is sealed with
7 the sealing material in the sealing step, the other sealing
8 material being inserted between the first panel and the second
9 panel at the rim.

1 23. The gas discharge panel production method of one of Claims
2 1 to 3 and 6 to 20, wherein
3 in the sealing step, the surrounding unit is sealed
4 while the first panel and the second panel is pressurized by
5 fastening tools pinching the first panel and the second panel at
6 the rim.

1 24. The gas discharge panel production method of Claim 23,
2 wherein
3 in the sealing step, the first panel and the second
4 panel are pinched by the fastening tools at an area in which the
5 barrier ribs are formed.

1 25. The gas discharge panel production method of Claim 23,
2 wherein
3 an anti-deformation member is disposed at the rim of
4 at least one of the first panel and the second panel to be used
5 in the surrounding unit forming step so as to prevent the first
6 panel and the second panel from deforming by pressure by the
7 fastening tools.

1 26. The gas discharge panel production method of Claim 25,
2 wherein
3 the anti-deformation member and the barrier ribs are
4 made of the same material.

1 27. The gas discharge panel production method of Claim 25,
2 wherein
3 the anti-deformation member is formed so as to prevent
4 the sealing material from flowing into an inner area of the
5 surrounding unit.

1 28. The gas discharge panel production method of Claim 25,
2 wherein
3 the anti-deformation member and the barrier ribs have
4 the same height.

1 29. The gas discharge panel production method of Claim 1,
2 wherein
3 in the sealing step, the surrounding unit is sealed
4 while an anti-displacement means for preventing a relative
5 displacement of the first panel and the second panel is disposed
6 on the surrounding unit.

1 30. The gas discharge panel production method of Claim 1,
2 wherein
3 an anti-sealing-material-inflow member is disposed at
4 the rim of at least one of the first panel and the second panel
5 to be used in the surrounding unit forming step so as to prevent
6 the sealing material from flowing into an inner area of the

7 surrounding unit.

1 31. The gas discharge panel production method of Claim 30,
2 wherein

3 the sealing material is disposed at outside the anti-
4 sealing-material-inflow member during the surrounding unit
5 forming step.

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1 32. The gas discharge panel production method of one of Claims
2 1 to 3 and 6 to 20 further comprising:

3 an adhesive application step for applying an adhesive
4 to top of the barrier ribs on the first panel, the applied
5 adhesive being to bond the top of the barrier ribs to the second
6 panel, and the adhesive application step being performed before
7 the surrounding unit forming step, and

8 in the sealing step, the top of the barrier ribs and
9 the second panel are bonded together by the applied adhesive as
10 the surrounding unit is sealed by the sealing material.

1 33. The gas discharge panel production method of Claim 32,
2 wherein

3 in the sealing step, the pressure adjustment sub-step
4 is started before the sealing material and the adhesive
5 harden.

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1 34. The gas discharge panel production method of Claim 32,
2 wherein

3 in the sealing step, the top of the barrier ribs and
4 the second panel are bonded together by softening and then
5 hardening the applied adhesive as the surrounding unit is sealed
6 by softening and then hardening the sealing material.

1 35. The gas discharge panel production method of Claim 34,
2 wherein

3 the sealing material and the adhesive are made of low-
4 melting glasses, and
5 softening point of the adhesive is lower than
6 softening point of the sealing material.

1 36. A gas discharge panel production method comprising:

2 a surrounding unit forming step for forming a
3 surrounding unit by putting a first panel and a second panel
4 together, wherein barrier ribs for partitioning light-emitting
5 cells are formed on a main surface of the first panel, and the
6 first panel and the second panel are put together to face each
7 other with the barrier ribs in between;

8 a sealing step for sealing the surrounding unit with
9 a sealing material inserted between the first panel and the
10 second panel at the rim; and

11 a bonding step for bonding top of the barrier ribs and

12 the second panel together by radiating an energy onto the top of
13 the barrier ribs to soften the top of the barrier ribs.

1 37. The gas discharge panel production method of Claim 36,
2 wherein

3 the top of the barrier ribs formed in the surrounding
4 unit forming step is made of a material which has a property of
5 absorbing the energy radiated in the bonding step.

1 38. The gas discharge panel production method of Claim 36,
2 wherein

3 the top of the barrier ribs formed in the surrounding
4 unit forming step is made of a black material.

1 39. A gas discharge panel production method comprising:

2 an adhesive application step for applying an adhesive
3 on top of barrier ribs which partition light-emitting cells, the
4 barrier ribs being formed on a first panel;

5 a surrounding unit forming step for forming a
6 surrounding unit by putting the first panel and a second panel
7 together to face each other with the adhesive on top of the
8 barrier ribs in between;

9 a sealing step for sealing the surrounding unit with
10 a sealing material inserted between the first panel and the
11 second panel at the rim; and

12 a bonding step for bonding top of the barrier ribs and
13 the second panel together by radiating an energy onto the
14 adhesive on top of the barrier ribs to soften the adhesive.

1 40. The gas discharge panel production method of Claim 39,
2 wherein

3 the adhesive applied in the adhesive application step
4 is made of a material which has a property of absorbing the
5 energy radiated in the bonding step.

1 41. The gas discharge panel production method of Claim 39,
2 wherein

3 the adhesive applied in the adhesive application step
4 is made of a black material.

1 42. The gas discharge panel production method of one of Claims
2 36 to 41, wherein

3 whichever comes first out of the sealing step and the
4 bonding step includes, or both of the sealing step and the
5 bonding step include:

6 a pressure adjustment sub-step for adjusting pressure
7 so that pressure inside the surrounding unit is lower than
8 pressure outside the surrounding unit.

1 43. The gas discharge panel production method of one of Claims

2 36 to 41, wherein

3 in the sealing step, the barrier ribs are observed in
4 terms of shape, and condition for radiating the energy is
5 controlled based on results of the observance.

1 44. A gas discharge panel production method comprising:

2 an adhesive application step for applying an adhesive
3 on top of barrier ribs which partition light-emitting cells, the
4 barrier ribs being formed on a first panel;

5 a surrounding unit forming step for forming a
6 surrounding unit by putting the first panel and a second panel
7 together to face each other with the adhesive on top of the
8 barrier ribs in between; and

9 a bonding step for bonding top of the barrier ribs and
10 the second panel together by heating the second panel to soften
11 the adhesive.

1 45. A gas discharge panel production method comprising:

2 a surrounding unit forming step for forming a
3 surrounding unit by putting a first panel and a second panel
4 together, wherein barrier ribs for partitioning light-emitting
5 cells are formed on a main surface of the first panel, and the
6 first panel and the second panel are put together to face each
7 other with the barrier ribs in between;

8 a sealing step for sealing the surrounding unit with

9 a sealing material inserted between the first panel and the
10 second panel at the rim; and

11 a bonding step for bonding top of the barrier ribs and
12 the second panel together by heating the second panel to soften
13 the top of the barrier ribs.

1 46. A gas discharge panel production method including a
2 sealing-off step for sealing off an exhaust pipe attached to a
3 surrounding unit by melting the exhaust pipe, the surrounding
4 unit including a pair of panels disposed to face each other, the
5 gas discharge panel production method comprising:

6 a first step for disposing a heating element at a
7 location a predetermined distance from the exhaust pipe; and

8 a second step for allowing the heating element to heat
9 the exhaust pipe.

1 47. The gas discharge panel production method of Claim 46,
2 wherein

3 in the first step, the heating element is disposed at
4 a location a predetermined distance from the exhaust pipe with
5 a restriction member in between.

1 48. An exhaust pipe sealing off apparatus for melting and
2 sealing off an exhaust pipe attached to a surrounding unit, the
3 surrounding unit including a pair of panels disposed to face

4 each other, the exhaust pipe sealing off apparatus comprising:
5 a heating element holding means for holding a heating
6 element at a location a predetermined distance from the exhaust
7 pipe, the heating element holding means being attached to the
8 exhaust pipe.

1 49. An exhaust pipe sealing off apparatus for melting and
2 sealing off an exhaust pipe attached to a surrounding unit, the
3 surrounding unit including a pair of panels disposed to face
4 each other, the exhaust pipe sealing off apparatus comprising:
5 a heating unit including a cylinder-shaped body inside
6 of which a heating element is held, the cylinder-shaped body
7 having an inner diameter larger than an outer diameter of the
8 exhaust pipe; and
9 a restriction member for restricting position of the
10 heating unit so that the heating unit is disposed around the
11 exhaust pipe at distance from the exhaust pipe.

1 50. The exhaust pipe sealing off apparatus of Claim 49,
2 wherein
3 the restriction member can be divided into two parts
4 by a plane passing center axis of the exhaust pipe.

1 51. The exhaust pipe sealing off apparatus of Claim 49 or Claim
2 50, wherein

3 the restriction member is disposed at two locations
4 or more along the exhaust pipe between the heating unit and the
5 exhaust pipe.

1 52. The exhaust pipe sealing off apparatus of Claim 49,
2 wherein

3 the heating unit further includes an insulation,
4 and

5 the heating element is shaped as a coil and is wound
6 inside the insulation.

1 53. A gas discharge panel produced with a production method
2 defined in one of Claims 1 to 3 and 6 to 20.

1 54. A gas discharge panel including a first panel and a second
2 panel, wherein barrier ribs for partitioning light-emitting
3 cells are formed on a main surface of the first panel, and the
4 first panel and the second panel are bonded together at the rim,
5 the first panel and the second panel facing each other with the
6 barrier ribs in between, wherein

7 top of the barrier ribs and the second panel are
8 bonded together by melting a material of the barrier ribs.

1 55. A gas discharge panel bonding apparatus comprising:

2 a surrounding unit housing unit for housing a

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3 surrounding unit which is formed by putting a first panel and a
4 second panel together, wherein barrier ribs for partitioning
5 light-emitting cells are formed on a main surface of the first
6 panel, and the first panel and the second panel are put together
7 to face each other with the barrier ribs in between; and

8 a sealing means for sealing the surrounding unit
9 housed in the surrounding unit housing unit by softening a
10 sealing material inserted between the first panel and the second
11 panel at the rim then hardening the sealing material; and

12 a pressure adjustment means for adjusting pressure so
13 that pressure inside the surrounding unit is lower than pressure
14 outside the surrounding unit.

1 56. The gas discharge panel bonding apparatus of Claim 55,
2 wherein

3 the sealing material is a low-melting glass, and
4 the sealing means includes a heating element which
5 heats and softens the sealing material.

1 57. The gas discharge panel bonding apparatus of Claim 56,
2 wherein

3 an adhesive made of a low-melting glass is applied to
4 top of the barrier ribs of the first panel housed in the
5 surrounding unit housing unit, and

6 the heating element heats and softens the adhesive as

7 well as the sealing material.

1 58. The gas discharge panel bonding apparatus of Claim 55,
2 wherein

3 an adhesive is applied to top of the barrier ribs of
4 the first panel housed in the surrounding unit housing unit,
5 and

6 the gas discharge panel bonding apparatus further
7 comprises:

8 a bonding means for bonding top of the barrier ribs
9 and the second panel together by softening and then hardening
10 the adhesive.

1 59. The gas discharge panel bonding apparatus of Claim 58,
2 wherein

3 the adhesive applied to the top of the barrier ribs
4 is made of a low-melting glass, and

5 the bonding means includes a laser beam radiating
6 apparatus which radiates a laser beam.

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